DSN Research and Technology Support

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The activities at the Venus Station (DSS 13) and the Microwave Test Facility (MTF), both operated by the Development Support Group, during the period Oct. 16–Dec. 7, 1975 are discussed and progress noted. Continuing testing of the remote-controlled automated station is noted as well as routine pulsar observations.. Automatic stability-reliability testing of the station maser–receiver–noise adding radiometer combination is described along with the data collected while so doing. Comparative measurements on the production version of the dichroic plate installed on the 64-m antennas are described along with mention of testing of a National Bureau of Standards (NBS) radiometer. Engineering measurements on the microwave power transmission test setup are described and a progress report of the X-Band Radar, Transmit-Receive; K-Band Receive (XKR) feedcone rehabilitation is given. Special testing of the new design feedcone for the Unified S-Band stations is mentioned, and measurements on interference received from the navigational equipment aboard military or commercial aircraft are described. Reporting of routine maintenance and support of clock synchronization transmissions and various radio science experiments is also included.

During the period Oct. 16–Dec. 7, 1975, the Development Support Group, in operating the Venus Station (DSS 13) and the Microwave Test Facility (MTF) supported various programs as discussed below.

I. Station Automation

Demonstration of a remotely operated automated station is planned using DSS 13 as the test station. Although a successful demonstration has been conducted (DSN Progress Report 42-30, pp. 214–221), refinement of software and reliability testing is continuing.

The antenna waveguide switch controller was modified, and computer monitoring of the position of the polarization selector and ambient load selector switches was provided. System testing and automated pulsar tracking continued. A total of 45 hours of station support time, including 17 hours of automated pulsar tracking, was provided during this period.

II. Pulsar Observations

In support of the Radio Science Experiment "Pulsar Rotation Constancy," DSS 13 provided 56-3/4 hours of observations during which the emissions from the pulsars tabulated in Table 1 were recorded. These data, recorded at 2388 MHz, left-circular polarization (LCP), are used to determine precise pulse-to-pulse spacing, pulse shape, and pulse power content of the signals emitted by these pulsars.

III. Maser–Receiver–Noise Adding Radiometer (NAR) Reliability–Stability Testing

Stability and reliability testing of the DSS 13 receiving system is conducted automatically during non-operational station periods. The 26-m antenna is pre-positioned in elevation and azimuth, and the NAR automatically records total system temperature as a function of time. The rotation of Earth sweeps the fixed antenna beam across the sky, resulting in generation of a radio brightness temperature sky map in addition to the data on stability and reliability of the system. During this period 391-1/4 hours of such data were automatically recorded with the antenna at 360 degrees azimuth and progressively positioned from 53.3 degrees to 52.7 degrees in elevation. Testing is done at 2295 MHz, using right-circular polarization (RCP) on the 26-m antenna.

IV. Dichroic Plate Measurements

The production versions of the dichroic plates used on the 64-m antennas contribute more system temperature than design and prototype testing indicate they should. Taking advantage of the removal of the DSS 14 Dichroic Plate for refurbishment of the XKR feedcone, DSS 13 positioned this plate atop the X-Band Low-Noise Antenna Measurement (XLA) feedcone which is operational for on-the-ground testing at DSS 13. A spot frequency measurement resulted in a system temperature of 20 K vice 16.5 K without the plate. Testing, using an angled flat sheet of aluminum and an absorber batten, indicated that a reflected signal entering from the side was contributing part of this additional system temperature.

Extensive additional measurements were conducted comparing the sensitivity of the plate to the operating frequency. The paint was then removed from the plate and "after" measurements conducted. Some frequency sensitivity was observed, but more testing of the prototype dichroic plate is necessary before final conclusions can be drawn. The plate was repainted and returned to DSS 14 for reinstallation.

V. National Bureau of Standards (NBS) Radiometer Testing

In support of Antenna Microwave Advanced Engineering and X and K-Band Propagation Calibration, an NBS design radiometer was tested at DSS 13. This testing, conducted at 2278.5 MHz, was to evaluate the stability, resolution, and overall usability of the NBS-designed radiometer. DSS 13 provided 25 hours of station support of which 22 hours were actual observing using the new radiometer. The dynamic range of the radiometer was less than desired, and further testing is planned after redesign and rebuilding.

VI. Microwave Power Transmission

Continuing with system testing (DSN Progress Report 42-30, pp. 214–221), measurements have been made of the sensitivity of the rectenna efficiency to angle of incidence of the arriving rays. Additionally, testing of system performance as a function of operating frequency and output power has been performed. By moving the 26-m subreflector, data have also been taken of the recovered power level as a function of transmitting antenna focusing. This last series of measurements indicates that additional efficiency could be gained by focusing the antenna on the rectenna instead of at infinity as was the case during preceding system testing.

System performance was demonstrated to a number of visiting groups including a contract motion picture film crew from the United States Information Agency. DSS 13 has provided 15-3/4 hours of system support, with the transmitter operating at various powers up to 250 kW during this period.

VII. X-Band Radar

In preparation for an additional series of radar observations, the XKR feedcone was removed from DSS 14 and brought to DSS 13 for extensive refurbishment of the radar system, including feedhorn, waveguide, waveguide switches, buffer amplifier, and protective circuits.

All waveguides, including the feedhorn, were removed. The voltage standing wave ratio (VSWR) of each piece of guide, as well as groups of pieces, was measured. All guides were then chemically cleaned, flanges lapped, and VSWR measurements again made. "Runs" of waveguide, as installed in the cone, were connected and VSWR measurements again made. The waveguide runs were "tuned" for minimum VSWR by careful deformation of the waveguide walls and the system was reinstalled, along with the cleaned feedhorn.

The buffer amplifier was completely bench-tested, and the prototype crowbar circuit (DSN Progress Report 42-30, pp. 214–221) was replaced by the production version. Response time measurements were made on all of the protective circuits (arc detectors, reflected power detectors, etc.), and an inhibit circuit was added to the traveling-wave tube (TWT) power supplies to prevent the power supplies from automatically restarting when shortcircuited by the crowbar circuit.

At the request of the Viking project, arrangements were made with Varian for accelerated delivery of a repaired klystron which was installed into the XKR feedcone on the DSS 14 antenna on Dec. 4, and system testing continued with two klystrons. This testing is still in progress.

VIII. Unified S-Band Feedcone Testing

Negotiations had previously been completed with Goddard Space Flight Center (GSFC) for dual-carrier testing at the Microwave Test Facility (MTF) of the new type feedcone to be installed into Spaceflight Tracking and Data Network (STDN) stations.

Using a test plan prepared by the feedcone contractor, dual-carrier testing at total power levels up to 24 kW was performed. The MTF provided dual transmitters of variable frequency and power as well as the necessary exciters, frequency sources, and a maser-receiving system with which to detect the intermodulation products generated by dual-carrier operation.

Testing was conducted at various powers up to 24 kW and transmitter operating frequencies from 2080 to 2120 MHz. System performance was good, with intermodulation products weaker than -141 dBm. Testing at MTF has been completed with further testing to take place at Goldstone STDN.

IX. DSN Receiver Interference Susceptibility Measurements

Among the possible sources of interference to flight operations is the radiation from commercial or military aircraft navigational gear, in particular the second harmonic from the Distance Measuring Equipment (DME). Several occurrences of interference seem likely to be from this source.

Tests were performed at DSS 13 utilizing the NASA shuttle aircraft to fly patterns around DSS 13 and operate the aircraft DME on each of the possible channels. When the aircraft was in the 26-m antenna beam, at ranges of approximately 2 km, interference was observed and recorded from each channel of the DME. Signal levels of approximately −138 dBm for the interference were recorded. Having the aircraft fly toward the antenna, remaining in the beam, was particularly useful as it allowed relatively long-term observation of the interfering signal on both a spectrum analyzer and a chart recorder.

X. Antenna Maintenance

The development activities which take place at DSS 13, particularly the development of various computer-controlled automation schemes, place unusual stress on the antennas. In particular, the azimuth drive gear boxes on the 26-m antenna have failed in the past. In order to forestall, if possible, future catastrophic failure, these gear boxes are being modified and refurbished. The last of the four gear boxes was removed from the 26-m antenna, replaced with a reworked spare, and sent to the vendor for modification and refurbishment.

Scheduled periodic checking revealed that the 9-m antenna was unbalanced. Removal of 907 kg (2000 lb) of balancing weight from the elevation axis brought the system into balance for smoother tracking in the elevation axis.

XI. Planetary Radio Astronomy

In support of the Planetary Radio Astronomy experiment, DSS 13 measures radiation received at 2295 MHz from the planet Jupiter and various radio calibration sources. These measurements utilize the 26-m antenna, the maser-receiving system, and the Noise Adding Radiometer (NAR). During this period, observations were made of the calibration sources tabulated in Table 2 in addition to measurements of Jupiter itself. A total of 40 hours of observations were made.

XII. Platform Parameters, Very Long Baseline Interferometry (VLBI)

In support of this development project, DSS 13, in conjunction with DSS 43, provided 16 hours of VLBI observations. During these 16 hours, 97 sources were observed, and the received data recorded onto magnetic tape utilizing a modified TV video recorder. These observations were made at 2290 MHz.

XIII. Clock Synchronization Transmissions

Although some troubles have been encountered with this system, three transmissions were made to DSS 42-43 and three to DSS 61-63. Difficulties encountered include failure of the programmed oscillator due to a power supply failure and a changed capacitor value in the computer interface. Additionally, the circulating water pump began leaking so badly that replacement was necessary. Repairs have been accomplished and the system is now operational.

Table 1. Pulsars observed at DSS 13

0355+54	0833−45	1642−03	1911−04	2121+51
0525+21	1133+16	1706−16	1929+10	2218+47
0736−40	1237+25	1749−28	1933+16	
0823+26	1604−00	1818−04	2045−16	

Table 2. Radio calibration sources observed at DSS 13

3C17	3C273	3C309.1	NGC 7027
3C48	3C279	3C348	Virgo A
3C123	3C286	3C353	